54. A projection aligner according to claim 24, wherein said optical unit comprises at least a diffuser.

55. A projection aligner according to claim 24, wherein said optical unit comprises at least a diffraction optical element.

56. A projection aligner according to claim 24, wherein said optical unit comprises at least an optical integrator.

REMARKS

Claims 1-34 are now presented for examination. Claims 1, 3-6, 10-16, 20-28 and 32-34 have been amended to define still more clearly what Applicants regard as their invention, in terms which distinguish over the art of record. Claims 35-56 have been added to assure Applicants of the full measure of protection to which they deem themselves entitled. Claims 1-3, 11-13 and 23-25 are the only independent claims.

Claims 4, 10, 14, 20, 21, 26, 32 and 33 have been objected to under 37 C.F.R. § 1.75(c) as being in improper form in that a multiple dependent claim should refer to other claims in the alternative only. Claim 4 has been amended to change the phrase "any one of claims 1, 2 and 3" to "claims 1, 2, or 3" as suggested in M.P.E.P. § 608.01(n) A. Claims 10, 14, 20, 21, 26,

32 and 33 have been similarly amended. Accordingly, it is believed that Claims 10, 14, 20, 21, 26, 32 and 33 fully meet the requirements of 37 C.F.R. § 1.75(c).

Claims 5, 6, 16, 27 and 28 have been rejected under 35 U.S.C. § 112, second paragraph, as indefinite. These claims have been objected to in that the elements noted in the claims are not equivalents of one another. Claims 5, 6, 16, 27 and 28 have been amended to include only a single element of those objected to. Each of the other objected-to elements of these claims has been separately recited in one of added Claims 35-56. It is therefore believed that Claims 5, 6, 16, 27 and 28 as amended, as well as newly added Claims 35-56 fully meet the requirements of 35 U.S.C. § 112, second paragraph.

Claims 1, 2, 5-9, 11-13, 15-19, 22-24, 27-31 and 34 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,028,967 (Yamada, et al.) in view of U.S. Patent No. 5,661,546 (Taniguchi). With regard to the claims as amended by this amendment, this rejection is respectfully traversed.

Independent Claim 1, as amended by this amendment, is directed to an illuminator that illuminates an object with luminous flux emitted from a light source. In the illuminator, an illumination system through which the luminous flux is projected onto the object has a surface on at least a portion of which a titanium oxide film is provided.

Pending independent Claim 2 is directed to an illuminator that illuminates an object with a luminous flux emitted from a light source. In the illuminator, an illumination system through which the luminous flux is projected onto an object has plural optical units. At least one of the plural optical units has a surface on at least a portion of which a titanium oxide film is provided.

Independent Claims 11, 12 and 13, as amended by this amendment, are directed to exposure apparatus that exposes a wafer with a pattern formed on a mask. In the exposure apparatus, an illumination system illuminates the mask with light from a light source. In Claim 11, the illumination system has a surface on at least a portion of which a titanium oxide film is provided. In Claim 12, the illumination system has plural optical units. At least one of the plural optical units has a surface on at least a portion of which a titanium oxide film is provided. In Claim 13, the illumination system includes plural optical elements and a supporting barrel supporting the plural optical elements. The barrel has an inside surface on at least a portion of which a titanium oxide film is provided.

Independent Claims 23 and 24, as amended by this amendment, are directed to a projection aligner that illuminates a pattern formed on a mask with a luminous flux and projects the pattern onto a wafer. The projection aligner has an illumination

system through which the luminous flux is passed. In Claim 24, the illumination system includes a plural optical units. In Claims 23 and 24, a projection system projects the pattern onto a wafer. At least one of the illumination system and the projection system has a surface on at least a portion of which a titanium oxide film is provided.

In Applicants' view, Yamada, et al. discloses an achromatic lens for ultraviolet rays that is constituted by (A) high-purity silica glass having a purity of 99.9% or more, or fluorine-containing, high purity silica glass having a purity of 99.9% or more and (B) silica glass containing germanium dioxide or silica glass containing germanium dioxide and boron oxide.

In Applicants' opinion, Taniguchi discloses a projection exposure arrangement with changing image characteristics and illumination conditions wherein, while a mask is illuminated under a predetermined illumination condition to transfer the image of the pattern of the mask to a substrate, the amount of imaging characteristic change of a projection optical system is calculated using calculation parameters corresponding to the illumination condition. Imaging characteristics are adjusted based on the calculated amount. When the pattern on the mask or the illumination condition is changed, the amount of imaging characteristic change is calculated based on an amount of energy stored in the projection optical system prior to the changing of

the condition. Pattern exposure is started immediately after the changing of the condition, and the imaging characteristics are adjusted based on the calculated amount.

According to the invention of Claims 1, 2 and 11-13, an illumination system that illuminates an object or a mask has an illumination system, an illumination system with plural optical units or an illumination system with plural optical elements supported in a barrel. The illumination system or at least one of the plural optical elements has a surface on at least a portion of which a titanium oxide film is provided or the supporting barrel has an inside surface on which at least a portion of which a titanium oxide film is provided. In Claims 23 and 24, at least one of an illumination system and a projection system has a surface on at least a portion of which a titanium oxide film is provided. Advantageously as disclosed at least at lines 2 through 19 of page 14 of the specification, the titanium oxide film functions as a photo-semiconductor by absorbing ultraviolet light to effectively prevent dust, hazardous substances in the air, and the like from adhering to and contaminating the surface of the illumination system even when the fabrication of semiconductor devices is performed for a long period of time.

It is a feature of Claims 1, 2, 11-13, 23 and 24 that a titanium oxide film is provided on at least part of a surface of

1) an illumination system, 2) at least one of plural optical units, 3) a barrel of an illumination system and 4) at least one of the illumination system and the projection system of a projection aligner. Yamada, et al. may, at lines 51 through 60 of column 1, disclose "There has also been proposed an achromatic lens constituted by a combination of a lens made of synthetic silica glass containing oxides of transition elements such as titanium, iron, etc., oxides of rare earth elements such as lanthanum, cerium, europium, etc., and a lens made of synthetic silica glass containing no additives, which utilizes the difference in dispersion power between them to remove the chromatic aberration". This Yamada, et al. disclosure only teaches the inclusion of titanium oxide within an achromatic lens but fails in any manner to suggest a titanium oxide film on at least a portion of a surface of an illuminator a projection optical system or an optical element or a barrel therein as in Claims 1-3, 11-13, 23 and 24.

Further, Yamada, et al. clearly discloses at lines 7-14 of column 2 "in the case of the lens made of synthetic silica glass containing oxides of transition elements and rare earth elements, these additives cause ultraviolet absorption, resulting in the reduction of transmittance and the generation of fluorescence. Accordingly, these additives are not suitable for achromatic lenses for ultraviolet rays, and rather should be removed." As a

result, Yamada, et al.'s teaching with respect to titanium oxide is directed against inclusion of titanium oxide in an achromatic lens and avoidance of any ultraviolet absorption and is devoid of any disclosure of using a titanium oxide film on the surface of an optical element as recited in Claims 1, 2, 11-3, 23 and 24 to effect photoconductivity responsive to ultraviolet absorption.

Taniguchi may disclose projection exposure apparatus in which a calculator calculates a correction value for an imaging characteristic of a projection optical system using predetermined calculation parameters and may teach calculating imaging characteristics based on magnification. The Taniguchi disclosure, however, is devoid of any suggestion of the use of a titanium oxide film on a portion of a surface of an optical unit. As a result, it is not seen that the addition of Taniguchi's projection exposure apparatus with calculation of imaging characteristics and correction values for imaging characteristics to the achromatic lens of Yamada, et al. with removal of any titanium oxide additive could possibly suggest the feature of Claims 1, 2, 11-13, 23 and 24 of a titanium oxide film on at least part of a surface of an illumination system, of at least one of plural optical units, of a barrel of an illumination system and of at least one of the illumination system and the projection system of a projection aligner. Accordingly, it is believed that Claims 1, 2, 11-13, 23 and 24 are completely

distinguished from any combination of Yamada, et al. and Taniguchi and are allowable thereover.

Claims 3, 13 and 25 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,358,198 to Moriyama, et al. (Moriyama) in view of Taniguchi. With regard to the claims as amended, this rejection is respectfully traversed.

Independent Claim 3, as amended by this amendment, is directed to an illuminator that illuminates an object with luminous flux emitted from a light source. In the illuminator, an illumination system through which the luminous flux is projected onto the object has plural optical elements and a barrel supporting the plural optical elements. The barrel has an inside surface on at least a portion of which a titanium oxide film is provided.

As discussed, independent Claim 13 as amended by this amendment is directed to exposure apparatus that exposes a wafer with a pattern formed on a mask. In the exposure apparatus, an illumination system that illuminates the mask with light from a light source has plural optical elements and a barrel supports the plural optical elements. The barrel has an inside surface on at least a portion of which a titanium oxide film is provided.

Independent Claim 25, as amended by this amendment, is directed to a projection aligner that illuminates a pattern formed on a mask with luminous flux and projects the pattern onto

a wafer. In the projection aligner, an illumination system through which the luminous flux is passed has plural optical elements and a barrel supporting the plural optical elements. A projection system that projects the pattern onto the wafer has plural optical elements and a barrel supporting the plural optical elements. At least one of the barrels of the illumination system and the projection system has an inside surface on at least a portion of which a titanium oxide film is provided.

Moriyama, et al., in Applicants' view, discloses an apparatus that moves a table or a stage having movable parts that is adapted to be guided by a guide rail to move slidingly and rectilinearly. At least the movable parts are made of a non-iron light metal material. The sliding surfaces of the movable parts that make sliding contact with the guide rail means are made of a self-lubricating material, while the sliding surfaces of the guide rails making sliding contact with the movable parts are made of a material having higher hardness and wear resistance than the non-iron light metal material, so that the weight of at least the movable parts is reduced to decrease the weight of the apparatus as a whole.

In accordance with the invention of Claims 3, 13 and 25, a barrel supporting optical elements has an inside surface on at least a portion of which a titanium oxide film is provided.

Moriyama, et al. only teaches apparatus that moves a stage used to move a specimen in a step and repeat reduction projection aligner system in which guide rails of a base are plated to improve wear resistance and lower the sliding friction coefficient.

As disclosed at lines 18-23 of column 3 of Moriyama, et al., "The use of the duralumin as the material of the movable parts such as guide rail means, X-table, Y-table and the like is not exclusive, and these movable parts may be constituted by other materials capable of achieving the reduction of weight, e.g., aluminum, aluminum alloy, magnesium, magnesium alloy, titanium, titanium alloy and so forth. Thus, any non-iron light metal can be used as the material" and further at lines 33-37 of column 3 "it is necessary that a layer is formed on the sliding surface of the guide rail with a material having higher hardness and wear resistance than the materials constituting the X and Y-tables and other movable parts". Accordingly, Moriyama, et al.'s plating of a rail with titanium or a titanium alloy to provide a sliding surface with higher hardness and wear resistance is directed away from and fails in any manner to suggest the feature Claims 3, 13 and 25 of a titanium oxide film on the inside surface of a barrel that supports optical elements that functions as a photo-semiconductor by absorbing ultraviolet light to effectively prevent dust, hazardous substances in the air, and the like from

adhering to and contaminating the surfaces in an illumination or projection system.

As aforementioned, Taniguchi discloses projection exposure apparatus in which a calculator calculates a correction value for an imaging characteristic of a projection optical system using predetermined calculation parameters and may teach calculating imaging characteristics based on magnification but is devoid of any suggestion of the use of a titanium oxide film on a portion of a surface of an optical unit. Moriyama, et al. is restricted to teaching plating rails for table movement thereon which may be titanium or a titanium alloy to improve hardness and wear resistance of the sliding surface of the rail.

Neither Moriyama, et al. nor Taniguchi in any way suggests the feature of a titanium oxide film on the inside surface of a barrel supporting optical elements as in Claims 3, 13 and 25. Accordingly, it is not seen that the addition of Taniguchi's projection exposure apparatus devoid of any use of an optical element supporting barrel having a titanium film on its inside surface to the titanium plated rails of Moriyama, et al. that provides higher hardness and wear resistance of a sliding surface could possibly suggest the feature of Claims 3, 13 and 25 of a barrel of an illumination or projection system that has an inside surface on at least a portion of which a titanium oxide film is provided. It is therefore believed that Claims 3, 13 and 25 are

completely distinguished from any combination of Moriyama, et al. and Taniguchi and are allowable.

A review of the other art of record has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record. Applicants submit that the amendments to independent Claims 1, 3, 11-13 and 23-25 clarify Applicants' invention and serve to reduce any issues for appeal.

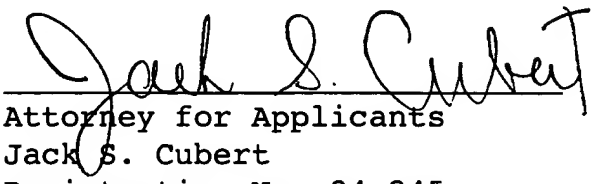
The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable consideration and reconsideration and early passage to issue of the present application. The Examiner is respectfully requested to enter this Amendment After Final Rejection under 37 C.F.R. § 1.116.

Applicants' attorney, Steven E. Warner, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All

correspondence should continue to be directed to our below-listed address.

Respectfully submitted,



Attorney for Applicants
Jack S. Cubert
Registration No. 24,245

FITZPATRICK, CELLA, HARPER & SCINTO
30 Rockefeller Plaza
New York, New York 10112-3801
Facsimile: (212) 218-2200

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Twice Amended) An illuminator for illuminating an object with a luminous flux emitted from a light source, said illuminator comprising:

an illumination system through which the luminous flux is projected onto the object, said illumination system [including at least one unit] having a surface on at least a portion of which a titanium oxide film is provided.

3. (Twice Amended) An illuminator for illuminating an object with a luminous flux emitted from a light source, said illuminator comprising:

an illumination system through which the luminous flux is projected onto the object, said illumination system including [at least one optical unit] a plurality of optical elements and a [supporting unit] barrel for supporting said [at least one optical unit] plurality of optical elements, said [supporting unit] barrel having [a] an inside surface on at least a portion of which a titanium oxide film is provided.

4. (Twice Amended) An illuminator according to [any one of] claims 1, 2, [and] or 3 wherein the luminous flux comprises ultraviolet light, and said titanium oxide film prevents a

contaminant from adhering to and contaminating the portion of the surface of the unit provided with said titanium oxide film due to a photoconductive function caused by absorption of the ultraviolet light.

5. (Twice Amended) An illuminator according to claim 1, wherein said unit comprises at least [one of] a diaphragm[, a shutter, and a lens barrel].

6. (Twice Amended) An illuminator according to either claim 1 or 2, wherein said unit comprises at least [one of] a lens[, a mirror, a prism, a filter, a diffuser, a diffraction optical element, and an optical integrator].

10. (Twice Amended) An illuminator according to [any one of] claims 1, 2, [and] or 3, wherein said titanium oxide film has a thickness ranging from 10 nm to 100 nm.

11. (Twice Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, [the pattern being illuminated with a luminous flux emitted from a light source and projected through an illumination system,] said exposure apparatus comprising:

[at least one unit] an illumination system for illuminating the mask with light from a light source,

said illumination system having a surface on at least a portion of which a titanium oxide film is provided.

12. (Twice Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, [the pattern being illuminated with a luminous flux emitted from a light source and projected through an illumination system,] said exposure apparatus comprising:

an illumination system for illuminating the mask with light from a light source,

said illuminating system having a plurality of optical units, at least one of said plurality of optical units having a surface on at least a portion of which a titanium oxide film is provided.

13. (Twice Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, [the pattern being illuminated with a luminous flux emitted from a light source and projected through an illumination system,] said exposure apparatus comprising:

an illuminating system for illuminating the mask with light from a light source,

[at least one optical unit; and]

said illuminating system including a plurality of optical elements and a barrel for supporting said plurality of optical elements,

[a supporting unit for supporting said at least one optical unit,] said [supporting unit] barrel having [a] an inside surface on at least a portion of which a titanium oxide film is provided.

14. (Twice Amended) An exposure apparatus according to [any one of] claims 11, 12, [and] or 13, wherein the luminous flux comprises ultraviolet light, and said titanium oxide film prevents a contaminant from adhering to and contaminating the portion of the surface of the unit provided with said titanium oxide film due to a photoconductive function caused by absorption of the ultraviolet light.

15. (Twice Amended) An exposure apparatus according to claim 11, wherein said [unit] illumination system comprises at least one of a diaphragm, a shutter, and a lens barrel.

16. (Amended) An exposure apparatus according to claim 12, wherein said optical unit comprises at least [one of] a

lens[, a mirror, a prism, a filter, a diffuser, a diffraction optical element, and an optical integrator].

20. (Twice Amended) An exposure apparatus according to [any one of] claims 11, 12, [and] or 13, wherein exposure is performed while the pattern on the mask is scanned synchronously with the wafer.

21. (Twice Amended) An exposure apparatus according to [any one of] claims 11, 12, [and] or 13, wherein said titanium oxide film has a thickness ranging from 10 nm to 100 nm.

22. (Three Times Amended) A method for fabricating a device by using an exposure apparatus according to any one of claims 11 to 21, said method comprising the steps of:

[emitting a luminous flux from a light source;

projecting the luminous flux through an illumination system;

disposing a reticle having a pattern formed thereon along a path traveled by the luminous flux;

providing a titanium oxide film on at least a portion of a surface of a unit of the exposure apparatus;]

exposing a wafer with [the] a pattern [formed on the reticle] of a mask by [illuminating the pattern with the luminous

flux emitted from the light source and projected through the illumination system] using said exposure apparatus; and

developing the exposed wafer.

23. (Twice Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and [exposing a wafer by] projecting the pattern onto [the] a wafer, said projection aligner comprising:

[a light source for emitting a luminous flux;]

an illumination system through which the luminous flux is passed[, said illumination system including at least one unit]; and

a projection [optical] system for projecting the pattern onto the wafer[, said projection optical system including at least one unit],

wherein [at least one unit of] at least one of said illumination system and said projection [optical] system has a surface on at least a portion of which a titanium oxide film is provided.

24. (Twice Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and [exposing a wafer by] projecting the pattern onto the wafer, said projection aligner comprising:

[a light source for emitting a luminous flux;]

an illumination system through which the luminous flux is passed, said illumination system including a plurality of optical units; and

a projection [optical] system for projecting the pattern onto the wafer, said projection [optical] system including a plurality of optical units,

wherein at least one of said plurality of optical units of at least one of said illumination system and said projection [optical] system has a surface on at least a portion of which a titanium oxide film is provided.

25. Twice Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and [exposing a wafer by] projecting the pattern onto [the] a wafer, said projection aligner comprising:

[a light source for emitting a luminous flux;]

an illumination system through which the luminous flux is passed, said illumination system including [at least one] a plurality of optical [unit] elements and a [supporting unit] barrel for supporting said [at least one] plurality of optical [unit] elements; and

a projection [optical] system for projecting the pattern onto the wafer, said projection optical system including [at

least one optical unit and a supporting unit for supporting said at least one optical unit] a plurality of optical elements and a barrel for supporting the plurality of optical elements,

wherein [a supporting unit of] at least one of the barrels of said illumination system and said projection [optical] system has [a] an inside surface on at least a portion of which a titanium oxide film is provided.

26. (Twice Amended) A protection aligner according to [any one of] claims 23, 24, [and] or 25, wherein the luminous flux comprises ultraviolet light, and said titanium oxide film prevents a contaminant from adhering to and contaminating the portion of the surface of the unit provided with said titanium oxide film due to a photoconductive function caused by absorption of said ultraviolet light.

27. (Amended) A projection aligner according to claim 23, wherein said unit comprises at least [one of] a diaphragm[, a shutter, and a lens barrel].

28. (Amended) A projection aligner according to claim 24, wherein said optical unit comprises at least [one of] a lens[, a mirror, a prism, a filter, a diffuser, a diffraction optical element, and an optical integrator].

32. (Twice Amended) A projection aligner according to [any one of] claims 23, 24, [and] or 25, wherein illumination and projection are performed while the mask and the wafer are synchronously scanned at a velocity ratio based on imaging magnification of said projection optical system.

33. (Twice Amended) A projection aligner according to [any one of] claims 23, 24, [and] or 25, wherein said titanium oxide film has a thickness ranging from 10 nm to 100 nm.

34. (Twice Amended) A method for fabricating a device, said method comprising the steps of:

[emitting a luminous flux from a light source;

illuminating a pattern formed on a reticle with the luminous flux;]

exposing a wafer [by projecting the pattern onto the wafer after the reticle is aligned with the wafer using a projection aligner including at least one unit having a surface on at least a portion of which a titanium oxide film is provided] with a pattern of a mask by using the projection aligner according to any one of claims 23 to 33; and

developing the exposed wafer.